

# Interventional Procedures Under CT Guidance in Pain Management (Cementoplasty Excluded)

B. KASTLER<sup>1</sup>, B. FERGANE<sup>2</sup>

Head of Department of Radiology<sup>1</sup> and Director of Laboratoire d'Imagerie et d'Ingenierie pour la Santé<sup>1</sup>,  
Pain Unit<sup>2</sup> University of Besançon; France

## Introduction

CT offers an excellent and safe mean of guiding procedures by displaying a very good contrast between soft tissues, bone, vessels. CT guidance in contrary to fluoroscopic guidance allows safe needle progression and precise positioning at target which reduces complications and optimizes procedure results. We will demonstrate step by step, our routinely used technique under CT-guidance (patient positioning, gantry tilting, saline injection, needle steering...). Examples at different anatomic sites are here presented which can be used either in addition to or as an alternative to other conventional methods in pain management. To perform CT interventional procedures one must first have a good understanding of the anatomical relationship of the target and the surrounding structures which determine the possible safe percutaneous pathways. Thus we will briefly recall the anatomy of the region of interest where the target has to be reached with emphasis on CT cross sectional imaging.

## CT Guidance Techniques

### *How do I do?*

As for any interventionnal procedure the patient must have normal clotting values and be informed about the procedure.

Most techniques are quite easy to perform under CT guidance on an out patient basis under local anesthesia.

- He is placed in a supine or prone position depending on the entry point.
- Axial CT contiguous slices of 5 mm in thickness are obtained on the region of interest with the aid of the scout-view. A bolus injection of contrast media may be given to display possible intervening vascular structures.
- A safe pathway is chosen in order to avoid inadvertent puncture of vessels or noble organs.
- An optimal entry point is determined and marked on the skin with a felt tip pen.
- The patient is draped in a sterile fashion, the skin scrubbed and sterilized, and local anesthesia is instilled at entry point.
- The needle is slowly and safely moved forward step by step under CT guidance until its tip is positioned on the target. Correct positioning of the needle can be verified by injecting contrast media and by stimulation mode when using radiofrequency.

## What Kind of Technique do I Use?

### *Radiofrequency Technique*

Radiofrequency (RF) ablation of nerves involves the placement of an insulated electrode-needle with uninsulated small tip precisely tar-

geted into nervous tissue. When the current flows heat is generated. In order to control thermal lesion size a constant electrode tip temperature has to be maintained for 1 to 2 min. so as to avoid tissue charring and boiling. The generator we use (Radionics RFG 3C generator) comes with disposable small (20 gauge) thermal-coupled electrodes. It allows RF ablation offers numerous advantages:

- 1) adequate control of lesion size.
- 2) control of needle placement by electrical stimulation with testing of possible pain reduction.
- 3) selective sensory lesion (with no motor damage).
- 5) lower incidence of complications.
- 4) ability to safely repeat RF ablations if the neural pathway regenerates.

It however requires an initial investment (RF generator), and RF electrodes are more costly than simple spinal needles. It is also more time consuming.

#### *Alcohol Technique*

– Percutaneous injection of alcohol (95%) or phenol (6%) can be used to perform neurolysis or as a destructive agent in tumor therapy. Alcohol which is fat and water-soluble may harm surrounding structures because of its uncontrolled diffusion. Alcohol diffusion is the main drawback and cannot be fully controlled.

– The correct position of the needle tip at target is determined by an injection of diluted contrast media with local anesthetic (20/80%), which allows to anticipate possible diffusion of the alcohol and also to perform a block test. Alcohol must be instilled slowly (aspiration is performed before injection to avoid accidental intravascular injection).

Rare complications can be minimized by injecting small volumes of alcohol and by correctly positioning the needle tip.

– Alcohol after injection is seen diluting the contrast media (hypodense area).

– An appropriate local anesthesia reduces a painful alcohol instillation.

– The needle is flushed with a small amount of sterile saline or anaesthetic and then removed.

– Alcohol is lower in cost and for some authors (and in our experience) has longer lasting effects than RF but has drawbacks (possible spread at distance);

#### *Steroid Infiltration*

– Percutaneous local injection of steroid can be used because of its analgesic and anti-inflammatory effects.

– Prednisolone (1ml/ 5ml volume which is equivalent to 25/125mg of prednisone) is our steroid of choice for spinal epidural or periganglionic foramina infiltration because of steroid-induced arachnoiditis risk.

– For peripheral infiltration we used a long-release glucocorticoid (cortivasol 1,5 ml which is equivalent to 75 mg prednisone).

#### **Pterygopalatine Ganglion Neurolysis**

Neurolysis or blockade of the pterygopalatine ganglion (PPG) is an efficient method in the management of pain in patients suffering from cluster headaches, PPG neuritis, postherpetic neuralgia, severe intractable cancer-related pain.

#### *Anatomy of the Pterygopalatine Fossa*

The pterygopalatine fossa is located directly posterior to the maxillary sinus.

It houses the internal maxillary artery, the pterygopalatine ganglion and the maxillary nerve. In general, the arterial component of the fossa lies anteriorly and the neural component, posteriorly.

#### *Targeting the Needle Tip at the Pterygopalatine Ganglion Under CT-Guidance*

The patient is placed in a supine position on the CT table with his head turned opposite to the side of puncture. Axial CT contiguous slices of 5 mm in thickness are made from the upper part of the zygomatic arch to the lower part of the maxillary bone. The pterygopalatine fossa is seen posterior to the maxillary sinus and anterior to the lateral pterygopalatine plate. The pterygopalatine ganglion is located at the slice level of the sphenopalatine foramen.

The entry point is located just above the zygomatic arch. A safe pathway is chosen in order to avoid damage to the internal maxillary artery. The needle is slowly and safely moved forward under step by step CT guidance until the needle tip is within the pterygopalatine fossa.

#### *Ethanol Neurolysis (figure 1)*

The correct position of the needle tip (disposable 22.5 gauge - 12.70 cm spinal needle

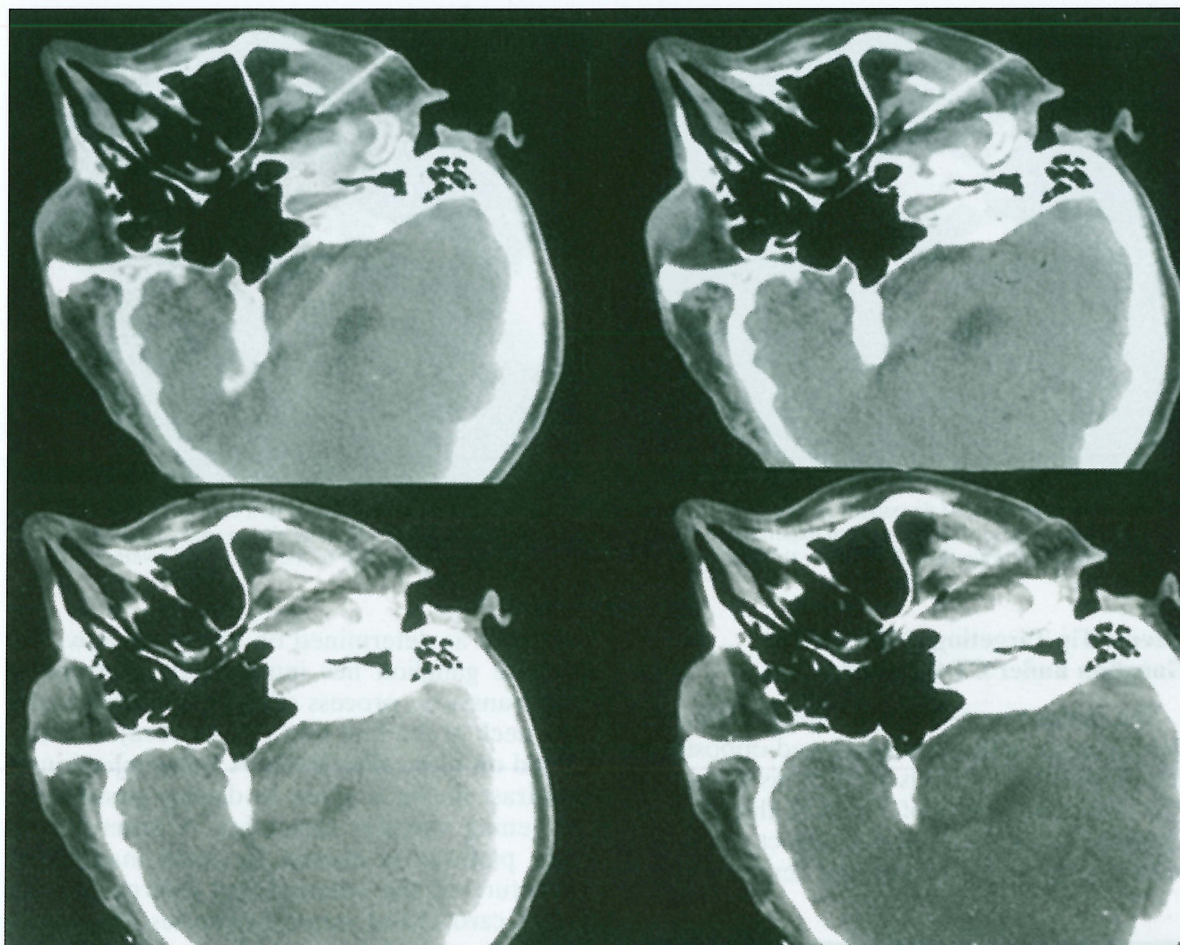


Figure 1 RF neurolysis in a patient with cluster headache. Needle is placed under step by step CT guidance (at target within the pterygopalatine fossa).

(BD) at target is determined by an injection of 0.5 ml diluted contrast media.

The neurolysis is performed with one ml of absolute alcohol which should be instilled slowly.

- Some patients experience epistaxis following this procedure. They should not be discharged until this condition has fully disappeared.

- Rare complications can be minimized by keeping the volume of injected alcohol within 1 ml and by correctly positioning the needle tip.

### **Stellate Ganglion Neurolysis**

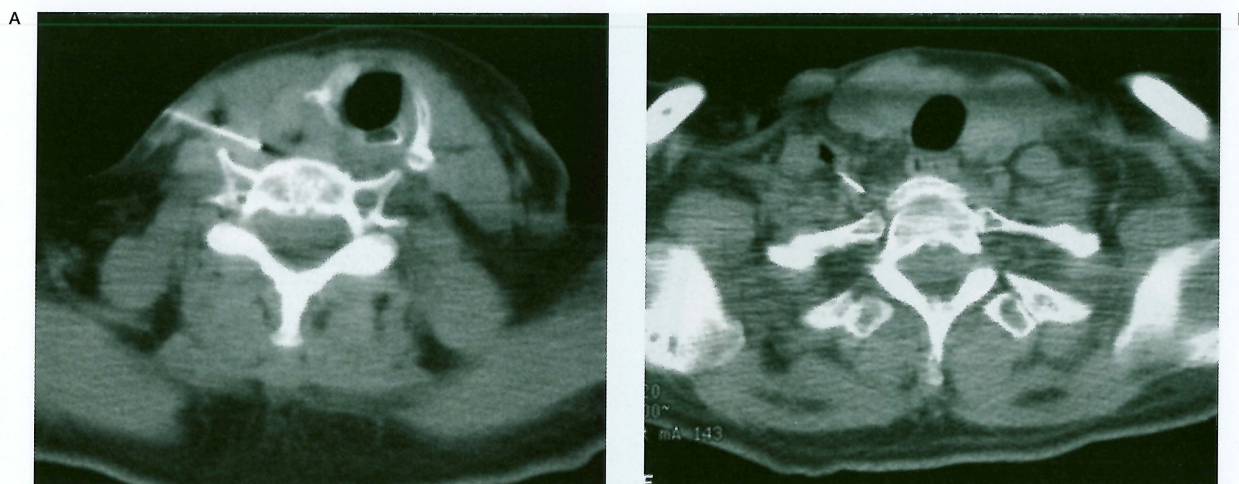
Neurolysis or stellate ganglion block is an efficient and accepted method in the diagnosis and treatment of acute and chronic sympathetically maintained pain syndrome of the upper

limb, thoracic viscera, and head and neck including causalgia, reflex sympathetic dystrophy, post herpetic neuralgia (also see indications for thoracic sympathectomy).

It is moreover effective in cases of severe intractable cancer-related pain arising from regional neoplasms invading the stellate ganglion (apex and cervical tumors).

### *Anatomic Basis*

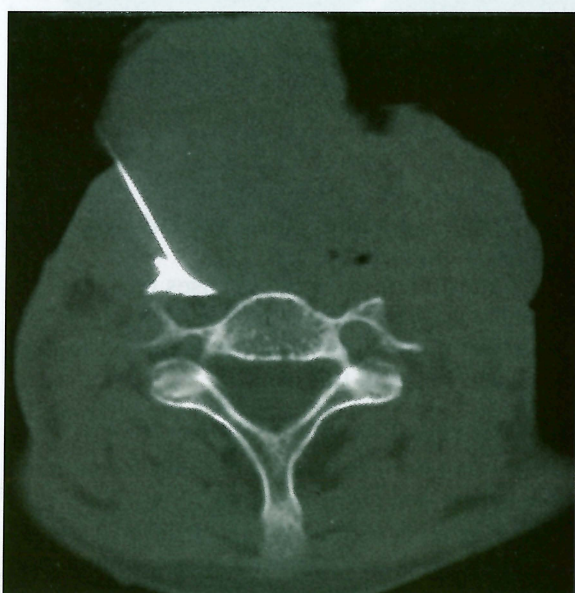
The stellate ganglion, a rather large oval-shaped structure 2.5 cm long, 1 cm wide, and 0.5 cm thick, is formed by the fusion of the inferior cervical and first thoracic sympathetic ganglia oriented in the axis of the spine. It is located anterior to the neck of the first rib, the transverse process of the C-7 vertebra and posterior to the vertebral artery originating from the subclavian artery;



**Figure 2** RF neurolysis. Male patient 39 years old. Three fingers of the left hand were sliced off in a chain saw accident. They were re-attached surgically. The patient experienced residual ischemic disorders and invalidating chronic pain. Excellent results were obtained following the RF ablation at both levels: the C-7 vertebra (A) and the neck of the first rib (T-1 vertebra (B).

### **Needle Tip Targeting at the Stellate Ganglion under CT-Guidance**

The patient is placed in a supine position on the CT table with his head turned opposite the side of puncture and his arms at his sides. Axial CT contiguous slices of 5 mm in thickness are obtained from the superior aspect of the C-6 vertebra through the superior level of the T2



**Figure 3** Alcohol neurolysis. Male patient 45 years old. Extruding vascularized mass corresponding to an advanced throat cancer. The patient was suffering from severe intractable cervical pain. Excellent results were obtained for the pain immediately following the procedure.

vertebra as determined on the scout view. The stellate ganglion lies immediately in front of the transverse process of the C-7 vertebra and the neck of the first rib (T-1 vertebra). It is targeted on these slice levels. A bolus injection of contrast media is given to display possible intervening vascular structures. A anterolateral safe pathway is chosen to avoid inadvertent puncture of the external and internal jugular veins, carotid and vertebral arteries. The needle is slowly and safely moved forward step by step under CT guidance until its tip is correctly positioned on the targets

### **RF Neurolysis (figure 2)**

The needle is a 20 gauge - 45 mm RF disposable cannula for RF probe (Radionics). A thermal lesion is created at a temperature of 60 to 80° for 60 to 120s. This procedure can be repeated up to three times moving the cannula forward and backward 1 mm each time. The C-7 level and the neck of the first rib both should be targeted for radiofrequency ablation.

The lesion size is adequately controlled. As described above, RF thermal neurolysis creates a discrete lesion which provides good pain relief, but which does not interrupt the entire ganglion function and does not tend to produce a Horner's syndrome.

### **Alternative Alcohol Neurolysis (figure 3)**

The correct position of the needle tip at target (C-7) is determined by an injection of dilut-

ed contrast media with local anesthetic. Alcohol neurolysis usually produce a Horner's syndrome and should be limited to patients with a low life expectancy (intractable cancer-related pain). Alcohol may diffuse to surrounding motor nerves: the C8 and T1 roots of the brachial plexus are particularly exposed as they are located posterior to the stellate ganglion (and the patient is supine) injected volume should be kept inferior to 1 ml.

### Celiac Plexus Neurolysis

Neurolysis of the celiac plexus is an efficient method to treat pain secondary to malignancies of the retroperitoneum and upper abdomen or secondary to pancreatitis.

#### Anatomical Background

The greater, lesser and least splanchnic nerves provide the major preganglionic contribution to the celiac plexus. The celiac plexus is anterior to the crus of the diaphragm extending in front of and around the aorta. The ganglia usually lie approximately at the level of the first lumbar vertebra, at the level of the celiac arterial trunk.

#### Needle Tip Targetting at the Celiac Plexus

The posterior transcrural approach with two needles and a trans-aortic approach is our technique of choice.

The patient is placed in the prone position with a pillow placed under the abdomen. Axial CT contiguous slices of 5 mm in thickness with injection of contrast media are obtained from the level of T-11 to L-2. The target level is chosen between the celiac arterial trunk and superior mesenteric artery (figure 4). The needles are moved forward step by step under CT guidance until their tips are positioned at the splanchnic nerves anterior and lateral to the vertebral body (3 ml of absolute alcohol preceded by 1.5 ml of diluted contrast are injected on both sites).

The left needle crosses the aorta to the region of the celiac ganglia. Adequate positioning is attested by a mixed anaesthetic/contrast injection (3-4 ml). The contrast media should be seen in the pre-aortic area and surrounding the aorta and celiac trunk (figure 4). A 10-15 ml volume of absolute alcohol is injected.

The anterior approach to the celiac plexus involves the passage of a fine needle through



Figure 4 Celiac plexus neurolysis in a patient with pancreas cancer using a posterior transcrural approach.

the liver, stomach, and pancreas (figure 5). It is most useful in patients who are unable to lie prone.

– The patient is observed for haemodynamic changes because of profound sympathetic blockade (orthostatic hypotension). Post-block diarrhea occurs in approximately 50% of patients.

### Pudental Nerve Infiltration

Pudental neuralgia is rare and very painful and invalidating. Infiltration has been found helpful in managing the pain and to predict efficacy of surgical decompression.

#### Anatomical Background

The pudental nerve is formed from the fusion of the 2<sup>nd</sup>, 3<sup>rd</sup> and fourth sacral nerves

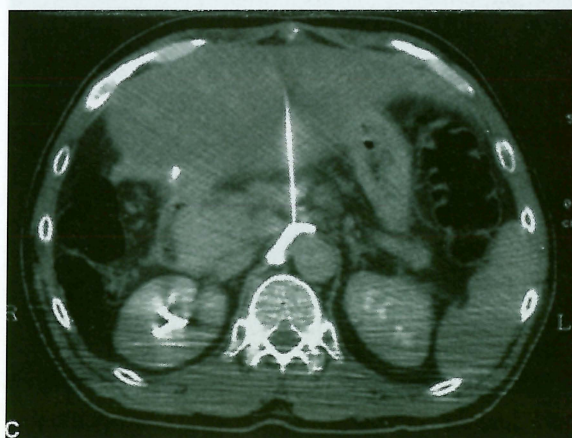


Figure 5 Celiac plexus via a anterior approach.

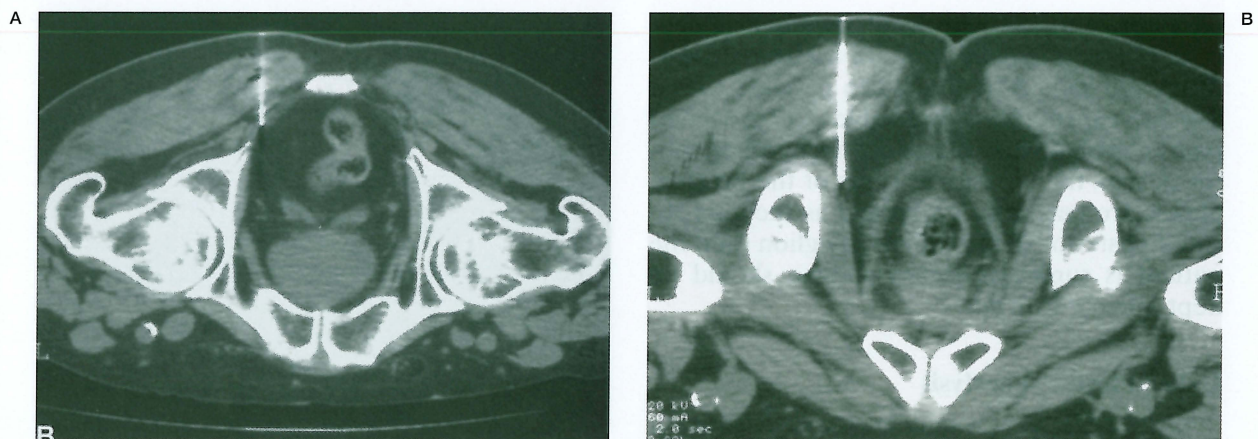


Figure 6 A) Needle tip in place at the level of the ischiatic spine between the sacrotuberal and sacrospinous ligaments. B) Needle tip in place at the Alcock's canal.

which merge posterior to the ischial spine. Anatomical study suggests that there are two possible conflicting sites: entrapment of the pudendal nerve during its course at the ischial

spine as the nerve can be entrapped under the sacrospinous ligament and/or the Alcock's canal a non stretchable aponevrotic tunnel.

#### *Infiltration Technique*

The patient is placed in a Prone position on the CT table. Axial CT contiguous slices of 5 mm thickness are realized on the projection of the obturator foramen.

The two possible conflict sites are targeted. Optimal entry points are determined choosing a grossly vertical course. The needle are slowly and safely advanced transglutally under step by step CT guidance.

Following the anesthetic block test (the patient should note a decrease in his pain), the infiltration is performed with 1 ml of long-release-glucocorticoid (cortivazol 3,75 mg) which should be slowly instilled at the 2 levels (4 sites if bilateral: dose per site 1/2 ml). After the infiltration the solution is seen within pudendal canal along the obturatorius internus muscle and between the sacrotuberal and sacrospinous ligaments.

#### **CT-Guided Nerve Root Block, Infiltration and Ablation**

CT guided periradicular steroid infiltration is an efficient method in patient with radicular pain with foraminal stenosis, herniated disk or postsurgical fibrosis refractory to medical treatment. A nerve root ablation (RF or alcohol) is sometimes useful for treating pain in patient with malignant disease.

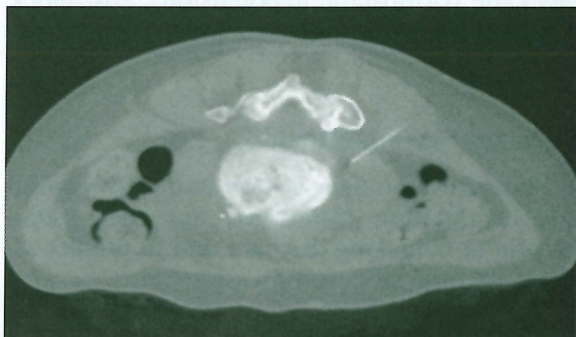


Figure 7 Periradicular steroid infiltration at the level of right L4-L5.



Figure 8 Epidural steroid infiltration at the L5 Level (on the right arrow)

The approach for needle placement varies according to the anatomic level (here for example at the lumbar level). The patient is placed in prone position with a pillow placed under the abdomen to flex the thoraco-lumbar spine. Axial CT images with 5 mm thick are realized to identify the intervertebral foramen for a direct posterolateral approach or slightly oblique by angling the gantry at the L5-S1 level or the sacral foramina.

The needle is advanced past the facet joint in front of the radicular nerve (figure 7). The nerve block is performed with 1% lidocaine (3 ml) or 0,5% bupivacaine. A steroid infiltration is performed with 75 mg of prednisolone. For a

cervical infiltration the patient is placed in a supine position head turned opposite to puncture site (figure 8).

### Conclusions

CT guided procedure can be used either in addition to or as an alternative to the conventional methods of pain therapy.

They are usually performed on an outpatient basis. CT-guidance allows a step by step control of the procedure and is much safer and reliable than fluoroscopy guidance. Radiologist should get skilled in this field of interventional radiology aimed at pain therapy.

### References

- Kastler B, Gangi A: Optimizing Interventional procedures under CT-guidance. Tips and Hints. Scientific exhibit presented at the Radiological Society of North America, 81st Scientific Assembly and Annual Meeting. Chicago, 1995.
- Clair C, Kastler B et Al: Neurolyse du ganglion sphéno-palatine sous contrôle tomodensitométrie. Radiologie J CEPUR, 1998, (Pterygopalatine ganglion neurolysis under CT guidance) Scientific Exhibit presented at RSNA, 1997.
- Gregoire A, Clair C et Al: Névralgie faciale essentielle traitée par neurolyse du ganglion sphéno-palatine sous contrôle tomodensitométrie. J Radiol 83: 1082-1084, 2002.
- Kitrelle JP, Grouse DS, Seybold ME: Cluster Headache. Local Anesthetic Abortive Agents. Arch Neurol 42: 496-498, 1985.
- Meyer JJ, Binns PM et Al: Sphenopalatine Ganglionectomy for Cluster Headache. Arch Otol 90: 475-484, 1970.
- Prasanna A, Murthy PSN: Combined Stellate Ganglion and Sphenopalatine Ganglion Block in Acute Herpes Infection. The Clinical Journal of Pain 9: 135-137, 1993.
- Malmqvist ELA, Bengtsson M et Al: Efficacy of stellate ganglion block: a clinical study with bupivacaine. Regional Anesthesia 17: 340-347, 1992.
- Carron H, Litwiller R: Stellate ganglion block. Anesth Analg 54: 567-570, 1975.
- Hogan QH, Erickson SJ et Al: Computerized tomography (CT) guided stellate ganglion blockade. Anesthesiology 77: 596-599, 1992.
- Kastler B, Clair C et Al: Stellate ganglion neurolysis under CT guidance. Radiologie J CEPUR, 1998 presented at RSNA, 1997.
- Kastler B, Michalakakis D et Al: Neurolyse du ganglion stellaire par radiofréquence sous guidage scanographique. Etude préliminaire JBR-BTR 84: 191-194, 2001.
- Ischia S, Luzzini A, Faggion SA: new approach to the neurolytic block of the celiac plexus: the transaortic technique. Pain 16: 333-341, 1983.
- Montero MA, Vidal LF et Al: The percutaneous anterior approach to the celiac plexus using CT guidance. Pain 34: 285-288, 1988.
- Robert R, Prat-Pradal D et Al: Anatomic basis of chronic perineal pain. Role of the pudental nerve. Surg Radiol Anat 20: 93-98, 1998.
- Goodson JD: Pudental neuritis from biking. New Eng J Med (letter) 304: 365, 1981.
- Amarenco G, Lanoe Y et Al: Syndrome du canal d'Alcock et névralgies périnéales. Rev Neurol 144: 523-526, 1988.
- Corréas JM, Belin X et Al: Infiltration scano-guidée dans le syndrome du canal d'Alcock chronique. Rev IM Med 2: 547-549, 1990.
- Kastler B, Clair C et Al: Pudental nerve infiltration under CT guidance. Scientific Exhibit. Radiological Society of North America, 83th Scientific Assembly and Annual Meeting Chicago. Radiology 1998.
- Kastler B, Clair C et Al: Interventional procedures under CT guidance in 756 patients, incidents, side effects and how to reduce their incidence. Scientific Exhibit. Radiological Society of North America, 88th Scientific Assembly and Annual Meeting. Chicago. Radiology 225, 724, 2002.

Bruno Kastler, M.D.  
Department of Radiology  
Director of Laboratoire d'Imagerie  
et d'Ingénierie pour la Santé  
University of Besançon,  
CHU Minjoz,  
25030 Besançon; France